

Serial No. 10/811,837
December 7, 2005
Reply to the Office Action dated August 11, 2005
Page 2 of 23

AMENDMENTS TO THE SPECIFICATION:

Please replace the first paragraph on page 1 of the originally filed specification with the following paragraph:

_____ This application is a Continuation-in-Part of U.S. Patent Application No. 10/437,239 filed May 14, 2003, ~~currently pending~~ now abandoned.

Please replace the paragraph bridging pages 8 and 9 of the originally filed specification with the following paragraph:

In the third preferred embodiment of the present invention, the piezoelectric substrate may preferably be a LiTaO₃ substrate, a pitch of an electrode finger of the comb-shaped electrode constituting the capacitance element may fall in any one of the ranges of the following expressions (1) to (3):

$$5300 \leq f_H \leq 5500 / f_H \geq 2 \times P \quad \dots \text{Expression (1)}$$

$$6800 / f_L \leq 2 \times P \leq 16500 / f_H \quad \dots \text{Expression (2)}$$

$$18800 / f_L \leq 2 \times P \quad \dots \text{Expression (3)}$$

Note that, in the expressions (1) to (3), f_H is an upper limit frequency of the pass band of the receiving-side surface acoustic wave filter, f_L is a lower limit of the pass band of the filter of the transmission-side surface acoustic wave filter, and P is an electrode-finger pitch of the comb-shaped electrode (a sum of a width of the electrode finger and a space between the electrode fingers).

Please replace the paragraph bridging pages 11-13 of the originally filed specification with the following paragraph:

According to the sixth preferred embodiment of the present invention, a surface acoustic wave duplexer includes an antenna terminal, a transmission-side surface acoustic wave filter which is connected to the antenna terminal and is formed using a piezoelectric substrate, a receiving-side surface acoustic wave filter which is connected to the antenna terminal and is formed using a piezoelectric substrate, a package

Serial No. 10/811,837

December 7, 2005

Reply to the Office Action dated August 11, 2005

Page 3 of 23

material on which the transmission-side surface acoustic wave filter and the receiving-side surface acoustic wave filter are mounted, a high-frequency wave element which has at least one inductor and at least one capacitance element, and a phase-adjusting strip line disposed in the package material. The inductor is formed on the same layers in the package material as that of the phase-adjusting strip line. The piezoelectric substrate including the transmission-side surface acoustic wave filter and the receiving-side surface acoustic wave filter is preferably a LiTaO₃ substrate. The capacitance element includes a comb-shaped electrode disposed on the piezoelectric substrate. The direction connecting electrode fingers of the comb-shaped electrode is substantially perpendicular to a propagation direction of a surface acoustic wave in the surface acoustic wave filter. The pitch of an electrode finger of the comb-shaped electrode falls in any one of the ranges of the following expressions (13) to (15):

$$5300/f_H \geq 2 \times P \quad \dots \text{Expression (13)}$$

$$6800/f_L \leq 2 \times P \leq 16500/f_H \quad \dots \text{Expression (14)}$$

$$18800/f_L \leq 2 \times P \quad \dots \text{Expression (15)}$$

Note that, in the expressions (13) to (15), f_H is an upper limit frequency of the pass band of the receiving-side surface acoustic wave filter, f_L is a lower limit of the pass band of the filter of the transmission-side surface acoustic wave filter, and P is an electrode-finger pitch of the comb-shaped electrode (a sum of a width of the electrode finger and a space between the electrode fingers).

Please replace paragraph bridging pages 14 and 15 of the originally filed specification with the following paragraph:

According to the eighth preferred embodiment of the present invention, a surface acoustic wave duplexer includes an antenna terminal, a transmission-side surface acoustic wave filter connected to the antenna terminal, a receiving-side surface acoustic wave filter connected to the antenna terminal, a package material on which the

Serial No. 10/811,837

December 7, 2005

Reply to the Office Action dated August 11, 2005

Page 4 of 23

transmission-side surface acoustic wave filter and the receiving-side surface acoustic wave filter are mounted, and a high-frequency wave element which includes at least one inductor and at least one capacitance element. One end of the transmission-side surface acoustic wave filter and one end of the receiving-side surface acoustic wave filter are connected at a common connection point. The high-frequency wave element is disposed only between the common connection point and the antenna terminal. The inductor is disposed in the package material. The capacitance element includes a comb-shaped electrode disposed on the piezoelectric substrate. The direction of an electrode-finger pitch of the comb-shaped electrode is turned substantially 90 degrees with respect to a propagation direction of the surface acoustic wave propagated on the piezoelectric substrate. The ripple caused by the capacitance element is not located at a twofold wave and a threefold wave or in the vicinity thereof of a pass band of the transmission-side surface acoustic wave filter and ~~that a pass band~~ of the receiving-side surface acoustic wave filter. The high-frequency wave element has both of a low-pass filter function and an antenna-matching function.

Please replace the paragraph bridging pages 24 and 25 of the originally filed specification with the following paragraph:

The low-pass filter 6 is constructed to use the resonance of the capacitance obtained by the delta-type connection of the first to the third capacitance elements 22 to 24 and inductance elements 29 and 30 which are embedded in the package material 11 shown in Fig. 2. Specifically, the inductance elements 29 and 30 are formed by forming electrodes in a plurality of layers in the package material 11 so as to define the inductor 28. The inductance elements 29 and 30 may be formed having a shape such as a spiral shape, a meandering shape, or suitable shape, depending on the inductance value. The inductance elements 29 and 30 are connected through a via hole electrode 31. One end of the inductance element 29 is connected to a wiring electrode (not shown in the figure) disposed on the upper surface of the package material 11 through a via hole electrode 32. Also, the inductance element 30 is connected to a via hole

Serial No. 10/811,837

December 7, 2005

Reply to the Office Action dated August 11, 2005

Page 5 of 23

electrode 33, and the via hole electrode 33 extends to a bottom surface and is connected to a wiring electrode (not shown in the figure) disposed on the bottom surface 11c of the package material 11. In the same manner as the inductance elements 29 and 30, an additional pair of inductance elements is formed (not shown in the figure).

Please replace the second full paragraph on page 32 of the originally filed specification with the following paragraph:

Also, the position of the second attenuation pole is determined by the resonance of the inductance element L_2-L_1 and the capacitance C_Z . Accordingly, because the position of the second attenuation pole is determined by $1/(2 \times \pi \times (L_2-L_1 \times C_Z)^{1/2})$ when the value of the capacitance C_Z becomes large, the frequency can be matched even if the value of the L_2-L_1 is small. Thus, miniaturization is easily achieved compared with the low-pass filters 36 and 37.

Please replace the paragraph bridging pages 33 and 34 of the originally filed specification with the following paragraph:

Also, the inductance elements 29, 30, and other elements are preferably formed in the package material 11. However, if the inductance elements 29, 30, and other elements are disposed at the transmission-side surface acoustic wave filter 3, a capacitive coupling and an inductive coupling can occur between the phase-matching strip lines 15 and 16, and thus the characteristic of the attenuation band can be extremely deteriorated. On the other hand, as in the case of the present preferred embodiment, when the inductance elements 29, 30, and other elements are spaced apart from each other in a direction of the main surface of the package material 11 and located on the side of the receiving-side surface acoustic wave filter 4, the above-described coupling is made very difficult. Thus, the deterioration of the characteristic of the attenuation band can be effectively prevented. Furthermore, the electrodes 19 and

Serial No. 10/811,837
December 7, 2005
Reply to the Office Action dated August 11, 2005
Page 6 of 23

~~20~~ of the inductance elements 29, 30, and other elements can be disposed over a plurality of layers and on the same plane with the strip lines 15 and 16. Thus, the miniaturization of the package material 11 and the simplification of the manufacturing process are achieved.

Please replace the paragraph bridging pages 35 and 36 of the originally filed specification with the following paragraph:

In this regard, f_H is an upper limit frequency of the pass band of the receiving-side surface acoustic wave filter, and f_L is a lower limit of the pass band of the filter of the transmission-side surface acoustic wave filter.

$$5300/f_H \leq 2 \times P \quad \dots \text{Expression (1)}$$

$$6800/f_L \leq 2 \times P \leq 16500/f_H \quad \dots \text{Expression (2)}$$

$$18800/f_L \leq 2 \times P \quad \dots \text{Expression (3)}$$

Please replace the paragraph bridging pages 50 and 51 of the originally filed specification with the following paragraph:

The surface acoustic wave duplexer according to the third preferred embodiment includes the package material on which the transmission-side surface acoustic wave filter and the receiving-side surface acoustic wave filter are mounted and a high-frequency wave element which has at least one inductor and at least one capacitance element. The capacitance element includes a comb-shaped electrode disposed on the piezoelectric substrate of the transmission-side and/or the receiving-side surface acoustic wave filter. The direction along an electrode-finger pitch of the comb-shaped electrode is a direction which is turned substantially 90 degrees with respect to the propagation direction of the surface acoustic wave in the surface acoustic wave filter on which the comb-shaped electrode is provided. Accordingly, relatively large capacitance can be obtained in the same area. Also, the above-described capacitance element is difficult to respond to a surface acoustic wave, thus undesirable ripples do not easily

Serial No. 10/811,837
December 7, 2005
Reply to the Office Action dated August 11, 2005
Page 7 of 23

occur. Also, the ripple which occurs by the capacitance element is not located at the pass band of the ~~transmission~~receiving-side surface acoustic wave filter and at the twofold wave and the threefold wave of the pass band of the ~~receiving~~transmission-side or in the vicinity thereof. Thus, a surface acoustic wave duplexer having a favorable frequency characteristic can be provided.